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ASBESTOS - DOMESTIC AND FOREIGN DEPOSITS

BY

OLIVER BOWLES

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By Oliver Bowles[2]

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6790." The paper is a section of a forthcoming report covering major phases of the asbestos industry.

[2] Supervising engineer, building materials section, U. S. Bureau of Mines.

GENERAL DISTRIBUTION

The United States has never attained importance as a producer of asbestos, the domestic output being only $1\frac{1}{2}$ to 3 percent of the quantity required to supply raw material for its extensive asbestos-product manufacturing industries. Production is centered in four principal countries--Canada, Rhodesia, Union of South Africa, and the Soviet Union. Since asbestos first became an important commercial commodity the Province of Quebec, Canada, has led in tonnage produced, but a large proportion of the output of this province is shorter, nonspinning grades. Since 1916 the Union of South Africa and Rhodesia have become increasingly important as sources of the higher-grade spinning fibers. Before the World War Russia ranked next to Canada as a producer of asbestos, but during the revolutionary period the industry in that country was almost at a standstill. In 1926, however, activity was revived, and each year since then production and exports have increased greatly.

Minor quantities of asbestos are produced in Cyprus, Australia, Finland, and several other countries.

Chrysotile is the leading product in all the producing countries, but substantial quantities of both blue (crocidolite) and brown (amosite) asbestos also are produced in the Union of South Africa. Minor quantities of anthophyllite and similar amphibole varieties are mined in the United States, Italy, Bulgaria, Finland, and several other countries.

DOMESTIC DEPOSITS

Chrysotile

Alaska.-Samples of strong, flexible chrysotile more than 6 inches long were obtained in 1932 from a deposit at Shungnak on the Kobuk River in far-northwestern Alaska. Apparently the asbestos is of the slip-fiber type, therefore it may be confined to shear zones. Three thin veins, of which the largest is about 3 inches wide, were uncovered at one point. Water transportation is available during the summer months.

Arizona.-Chrysotile asbestos was discovered in the Grand Canyon of Arizona about 1900; and small quantities were mined on the north side opposite Grand View, about 20 miles west of Grand View, and at other points. About 1913 deposits were found 40 miles northeast of Globe, where many workings have been established over an area 60 miles long and 25 miles wide, most of which lies west of the San Carlos and Apache Indian Reservations. The more important deposits are at Chrysotile and near Rice on Ash Creek, where extensive underground mines have been developed. Deposits also have been worked on Salt River near the summit of Coon Creek Butte, near the head of Sloane Creek (a branch of Canyon Creek), and at various other points.

Arizona asbestos apparently originated as an alteration product of the Mescal dolomitic limestone, due to metamorphism by diabase intrusions. It occurs in cross-fiber veins, which are most abundant throughout the limestone close to the contact surfaces, and is often associated with nodules of massive serpentine. The veins occur in relatively narrow zones, most of which must be mined by underground methods. The highest-grade Arizona fiber is soft and silky, has high tensile strength, and is excellent for spinning purposes. A harsher fiber, however, is associated with the soft in many places. Arizona chrysotile is very low in iron, therefore it is generally considered more suitable for electrical insulation than chrysotile from other regions.

The location of the deposits, most of which are many miles from a railroad, and the long and expensive rail haul to eastern markets have confined mining chiefly to the longest and highest-grade fibers. Production never has exceeded a few hundred tons a year, attaining a maximum of 1,200 tons in 1920. A new highway, under construction in 1933, from Springerville to Globe will lower the cost of transportation and encourage enlarged development.

California.-The only output of chrysotile in California worthy of mention was from Nevada County, where for a few years before 1922 short fiber and a little spinning fiber were produced. Chrysotile also was produced in small quantities near Monticello, Napa County, in 1932. It has been found in many other places in the State, and several mills for its recovery have been built. Most of the deposits are of uncertain extent, the fiber is short, and production has been almost negligible.

Montana.-Chrysotile asbestos occurs near Cliff Lake, southern Madison County. It is associated with serpentine in limestone close to a diabase contact. Development of deposits began in 1917, and a mill was under construction in 1923 and 1924, but commercial production has been very small. Samples of the fiber examined by the Bureau of Mines were weaker and more brittle than Canadian or Arizona chrysotile.

Vermont.-Although asbestos in Vermont was first discovered in 1824 near Lowell, no interest was taken in it until 1899 when its resemblance to the Canadian variety was recognized.

The Vermont fiber is chrysotile, which is similar in character and occurrence to that found at Thetford Mines, Quebec, the deposit being regarded as a southward extension of the well-known Canadian belt. The asbestos is of two kinds - cross-fiber veins passing irregularly through serpentine and slip fiber lying parallel to slickensided surfaces. Most of the cross-fiber veins are narrow, those over three fourths inch in width being uncommon. The slip fiber ranges from a fraction of an inch to 3 or 4 inches long and is somewhat coarser than the crossfiber; however, it is not suitable for spinning. The claim has been made that the proportion of fiber to rock runs 8 to 12 percent, which is somewhat greater than in the Canadian field. The yield of spinning fiber, however, is very small.

Asbestos-bearing rocks occur in four prominent localities in Lamoille and Orleans Counties. The first occurrence, which is undeveloped, is about 2 miles northeast of Lowell. It consists of numerous cross-fiber veins and some slip fiber in serpentine. The second deposit, northwest of Lowell in the vicinity of Westfield, is in the form of a belt several miles long and a mile wide. Considerable slip fiber and cross fiber occur in places, but none has been mined. In the third locality, which is southwest of Lowell near Mount Belvidere, slip fiber predominates. A mill was erected in this district in 1902 by the New England Asbestos Mining & Milling Co. but was operated only 6 months. The fourth serpentine area, extending about 2 miles eastward from the third, occupies a prominent bluff on the shoulder of Belvidere Mountain. Both slip-fiber and cross-fiber veins occur, the latter providing a small amount of crude asbestos. On this property the Lowell Lumber & Asbestos Co. in 1907 erected a mill with a daily capacity of about 200 tons of rock. Production was first recorded in 1908, and in 1909 the industry was so active that Vermont became the chief asbestos-producing State. In 1910 the output increased 24 percent over that in 1909. In 1911 the total production of the United States, 7,604 tons, was largely from Vermont. During that year considerable no. 2 crude was obtained. In 1912 Vermont, with a production of 4,403 tons, had the distinction of being the only asbestos-producing State in the Union, but for several years thereafter no activity was noted.

The industry was revived about 1920 but not in the location formerly most productive. Since then operations have been confined to the opposite side of the deposit at the former quarry site of the New England Asbestos Mining & Milling Co. Slip fiber predominates in this region, there being little or no spinning fiber. A mill was built, and experimental runs were made, but there was practically no commercial production until 1929 when under new management the output was over 1,000 tons. Since 1929 Vermont has been a consistent producer of several grades of mill fiber.

Wyoming.-A small production of chrysotile was reported from Wyoming in 1892 and from 1906 to 1912. Asbestos occurs in a serpentine area of approximately 4½ square miles on Casper Mountain about 8 miles south of Casper and in the Smith Creek area of about 7 square miles 20 miles southeast of Casper, both in Natrona County. The mineral occurs principally as cross-fiber veins, few of which are more than an inch across, but a minor quantity of slip fiber appears in places. A mill was built in the Smith Creek area in 1910 and another on Casper Mountain in 1911, but very little fiber has been produced.

Occurrences of spinning-grade asbestos near Lander and Atlantic City, Freemont County, were reported in 1919, but the properties have not been developed. A small quantity was obtained at Wheatland, Platte County, in 1920. Chrysotile has been found in several other places, but most of the occurrences throughout the State are relatively low-grade, short fibers.

Other occurrences.-Although amphibole is the prevailing type of asbestos in North Carolina, chrysotile also occurs in several places. Chrysotile veins 2 inches wide were found near North Wilkesboro, Wilkes County, in 1902. An opencut 100 feet long was made, but no production has been reported. Another occurrence has been noted 3 miles west of Spruce Pine, Yancey County.

A deposit near Round Hill, Loudoun County, Va., was reported in 1894. Small stringers of asbestos also occur in massive serpentine near Great Falls, Fairfax County.

Chrysotile was found in 1902 near Ishpeming, Marquette County, Mich., and some development work was done.

Amphibole

California.-Small deposits of amphibole asbestos occur in many places in California. Until 1905 the limited production from many counties was of the amphibole variety. A slip-fiber anthophyllite was mined for several years in Shasta County, but no activity has been noted since 1923. A small output was reported from Kern County in 1928. There is no prospect at present of the industry attaining importance.

Georgia.-Georgia has been the most consistent producer of amphibole asbestos of any of the States. The largest quantity has been obtained from deposits on or near Sall Mountain in the vicinity of Helen, Santee, Cleveland, and Nacoochee, White County. These deposits have produced with some interruptions since 1894 and possibly in a small way during earlier years. The asbestos is of the mass-fiber anthophyllite type. It is claimed that 90 to 95 percent of the rock quarried is fiber. The best asbestos is near the surface where weathering has made it soft and flexible. The solid, unweathered rock is less desirable and requires different treatment. Resources of the best fiber therefore are relatively limited, and most of the available high-grade material is exhausted. The fiber is prepared for use in a mill at Gainesville, about 27 miles from the deposits. It is employed principally for fireproofing, for insulation, and in paint manufacture.

Another production center of some importance, particularly from 1924 to 1927, is Hollywood, Habersham County. The fiber, which occurs in a deposit about 90 feet wide, is harsher and less silky than that at Sall Mountain. After much experimental work hammer-mill methods of fiberizing were introduced, and several grades of asbestos were prepared. The products were sold for heat insulation and as filler for composition flooring, plaster, battery boxes, and rubber. Little or no production has been recorded since 1927.

From 1923 to 1927 a small output of anthophyllite was reported from a property on Bear Creek $1\frac{1}{2}$ miles northeast of Statham, Barrow County. It was used principally for filtering acids.

Amphibole asbestos deposits at various other points in Georgia have not attained commercial importance. Many of them have been described by Hopkins.3/

3/ Hopkins, Oliver B., Asbestos, Talc, and Soapstone Deposits of Georgia: Geol. Survey of Georgia Bull. 29, 1914, pp. 142-189.

Idaho.-A little amphibole asbestos has been mined 14 miles southeast of Kamiah, Idaho. It was used for pipe and boiler covering and in wall plaster and paint. The deposit consists of brittle mass-fiber anthophyllite occurring in lenticular masses, some of which are 200 feet long and 35 feet thick. In 1922 equipment was installed for sawing fire blocks and insulating brick, but the project did not materialize. No production has been reported since 1925.

Maryland.-Asbestos occurrences were noted in western Maryland as early as 1883, but no production worthy of mention was recorded until 1917. In that year a slip-fiber anthophyllite deposit was developed near Pylesville, Harford County. The asbestos occurs in gneissoid schists that have been softened by weathering. The veins generally are small, and the usable fiber is confined to a zone near the surface. The good asbestos extends to greatest depths along shear zones where movement and pressure have been greatest. Mining has been conducted to a depth of about 50 feet.

The fiber is unusually strong and tough and is especially adapted to making acid filters; therefore it is more valuable than anthophyllite from other localities. It is prepared for market at a factory at Woodlawn, a suburb of Baltimore. Before this deposit was discovered supplies of acid-filter fiber were obtained from Italy.

Montana.-A deposit of anthophyllite asbestos, said to be extensive, in Gallatin County about 17 miles south of Gallatin Gateway is worked for a small production of insulating material. The fiber occurs in a dense, hard form but breaks down readily to a soft, fluffy mass. Occasional pockets and lenses contain strong, silky fiber much of which is an inch or more in length. It is of spinning quality and is the only amphibole of such grade in the United States known to the Bureau.

A small shipment of anthophyllite was recorded in 1928 from a property on Rainey Creek 7 miles northeast of Libby, Lincoln County.

Oregon.-Sixty-four tons of amphibole asbestos produced in Oregon were sold in 1892. In 1917 a small mine was operated a few miles north of Mount Vernon, Grant County. Asbestos occurring near Hereford, Baker County, was described in 1922 as a soft, long-fibered tremolite. Development work on the property was reported in 1925, and in 1926 a 310-foot tunnel was driven. A small production for experimental purposes was reported in 1929.

Virginia.-Anthophyllite asbestos occurs about 12 miles south of Bedford, Bedford County. The prevailing associated minerals are hornblende and olivine. Unlike the mass-fiber deposits of Georgia and Idaho the best asbestos is the slip-fiber type, occurring in veinlike masses occupying shear zones. Several veins have been noted, and one 18 inches thick supplied considerable fiber from 1904 to 1911. A mill for treating the asbestos was erected in Bedford in 1903. The available supply is probably small, as very little has been produced since 1911. A small quantity has been used in the manufacture of Tenax, a preparation used by dentists.

A deposit of slip-fiber amphibole occurs also at Rocky Mount, Franklin County. A shaft was sunk to a depth of 40 feet, and 40 tons were obtained from this mine in 1907.

Washington.-Amphibole asbestos has been mined near Pateros, Okanogan County, for use in paints. A small production also was reported in 1930 and 1931 from Burlington. The material was used in boiler cement, roofing, and acoustic plaster. Undeveloped deposits have been noted at many other points.

Other occurrences.-Many other occurrences of amphibole asbestos were known from 1880 to 1905. The following localities, mentioned in early records, evidently had small importance as sources of supply: Staten Island and Long Island, N. Y.; New Brunswick, N. J.; Media and Colerain, Pa.; Lawrence County, S. Dak.; Stevens Point, Wood County, Wis.; Pickens, S. C.; Baraga County, Mich.; and New Hartford, Conn., where a small mill was operated in 1903. From 1901 to 1906 a small output of asbestos was reported near Dalton, Mass. It was first thought to be chrysotile but was identified definitely as anthophyllite in 1906. Numerous small isolated deposits of amphibole asbestos have been reported in Ashe, Avery, Buncombe, Jackson, Macon, Maywood, Mitchell, and Yancey Counties, N. C. Several small mills have been built, but production has been insignificant. Blue asbestos (crocidolite) occurs at Beacon Pole Hill near Manville, Providence County, R.I., but not in commercial quantities. Amphibole asbestos of uncertain quality has been found on Admiralty Island and at Chitina on the Copper River, Alaska.

PRINCIPAL FOREIGN DEPOSITS

Canada

The asbestos deposits in the Eastern Townships of the Province of Quebec, Canada, have been famous since 1878. They are situated 100 to 175 miles from Montreal and somewhat nearer Quebec, occupying a stretch of high ground known as the Notre Dame Hills - an extension into Canada of the Green Mountains of Vermont. The hills continue northeastward to the Gaspé Peninsula, and serpentine is exposed in many places throughout their length. Commercial asbestos occurs in two places, the Thetford Mines district, described later, and the Eden (Vt.), district, which has been covered in the discussion of domestic deposits.

The Quebec area, about 70 miles long and a maximum of 5 or 6 miles wide, lies between Danville and East Broughton. Within this section are six producing centers - East Broughton, Robertson, Thetford Mines, Black Lake, Coleraine, and Danville. The geology of the district has been covered in detail by Cirkel.[4] The asbestos, a chrysotile of exceptionally high quality, occurs in serpentine that forms part of a great belt of basic intrusive rocks.

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[4] Cirkel, Fritz, Chrysotile Asbestos - Its Occurrence, Exploitation, Milling, and Uses: Mines Branch, Canada Dept. of Mines, 2d ed., 1910.

Slip fiber occurs prominently in the East Broughton and Robertson areas, although little is found in the rest of the belt where cross-fiber veins traversing the serpentine irregularly abound. Veins of the latter type range from mere threads to several inches in width. The widest cross-fiber veins occur in the Thetford Mines area. Width of veins is important because it governs largely the fiber length. Asbestos from the larger veins is not passed through a mill but is hand-cobbed. It is known as "crude fiber" - the highest grade of spinning fiber produced. "Mill fiber" is that obtained by mechanical separation in mills.

The percentage of fiber in the rock is low. According to Ross[5/] 6,208,970 tons of rock were mined in 1929 and total fiber recovery (excluding asbestic) was 311,204 tons. The yield was 5 percent of the total rock mined and 7.7 percent of the rock milled. The value of the asbestos recovered was $2.12 per ton of rock mined and hoisted. Fiber classed as crude constituted only 1½ percent of the asbestos recovered. The output of spinning fiber, including crudes and the highest-grade mill fiber, was 24,415 tons (7.8 percent of the gross yield). Figures for other years vary little from those given above. The average recovery of fiber from milled rock is about 6 percent. Although Canada produces substantial quantities of spinning fiber considerably more than 90 percent of its production consists of the shorter (consequently relatively cheap) grades for which, fortunately, an extensive market exists in the United States.

The reserves of asbestos in Quebec are very large. Some of the workings are more than 400 feet deep, and core drilling has revealed an abundant supply of fiber at depths of more than 1,700 feet as high in quality as that near the surface.

The following table, compiled partly by Fisher, shows the annual production and value of asbestos in Quebec since the industry was first established.

[5/] Ross, J. G., Chrysotile Asbestos in Canada: Mines Branch, Canada Dept. of Mines Bull. 707, 1931, table 1, p. 60.

Annual production (shipments and sales) of asbestos in Quebec, 1878-1932[1]

Year	Production	Total value	Average value per ton
1878........	50	- - - -	- - - -
1879........	300	$19,500	$65.00
1880........	380	24,700	65.00
1881........	540	35,100	65.00
1882........	810	52,650	65.00
1883........	955	68,750	72.00
1884........	1,141	75,097	65.81
1885........	2,440	142,441	58.37
1886........	3,458	206,251	59.65
1887........	4,619	226,976	49.55
1888........	4,404	255,007	57.90
1889........	6,113	426,554	69.77
1890........	9,860	1,270,240	128.82
1891........	9,279	999,878	107.75
1892........	6,082	390,462	64.16
1893........	6,331	310,156	48.99
1894........	7,630	420,825	55.15
1895........	8,756	368,175	42.04
1896........	10,892	423,066	38.84
1897........	13,202	399,528	30.26
1898........	15,893	496,340	31.23
1899........	15,571	581,667	37.36
1900........	21,408	719,416	33.60
1901........	33,466	1,274,315	38.70
1902........	30,634	1,161,870	37.92
1903........	29,261	916,970	31.94
1904........	35,479	1,186,970	33.43
1905........	48,960	1,476,450	30.16
1906........	61,675	2,143,653	34.76
1907........	61,985	2,455,919	39.62
1908........	65,157	2,551,596	39.16
1909........	64,965	2,296,584	35.35
1910........	80,605	2,667,829	33.10
1911........	102,224	3,026,306	29.60
1912........	111,175	3,059,084	27.52
1913........	136,609	3,830,504	28.04
1914........	107,401	2,895,535	26.96
1915........	113,115	3,544,362	31.34
1916........	133,339	5,182,905	38.87
1917........	137,242	7,198,553	52.45
1918........	142,375	9,019,899	63.35
1919........	135,862	10,932,289	80.47
1920........	179,891	14,749,043	81.99
1921........	87,475	5,199,789	59.44
1922........	160,339	6,053,063	37.75
1923........	216,804	7,364,260	33.97
1924........	208,762	6,561,659	31.37
1925........	273,522	8,976,645	32.82
1926........	278,689	10,095,487	36.22
1927........	274,798	10,621,571	38.65
1928........	273,033	11,238,361	41.16
1929........	306,055	13,172,581	43.04
1930........	242,113	8,390,164	34.65
1931........	164,297	4,812,835	29.29
1932........	122,977	3,039,721	24.72

[1] Figures for 1878-1922 from The Quebec Asbestos Industry, by Norman R. Fisher: Canadian Min. Jour., Aug. 17, 1923, p. 651. Figures for 1923-32 published by the Quebec Dept. Colonization, Mines, and Fisheries, Bureau of Mines.

Until 1891 virtually the entire Canadian output was crude fiber, but thereafter both crude and milled asbestos were produced. This change in the character of products is reflected in the lower average value per ton beginning with 1892. The exceptionally high average values from 1918 to 1920 may be attributed to the abnormally high prices obtained for crude fiber on account of war conditions. Crude no. 1, for example, sold for more than $3,000 a ton during part of this period.

The Canadian deposits occupy an exceptionally favorable position, as they are within easy reach of extensive markets in the United States. The Quebec industry doubtless will maintain its advantage indefinitely in the short-fiber market, because high freight charges on relatively low-priced products discourage transoceanic competition. The future of the spinning-fiber industry in Canada is not so bright, because the price per ton of this type is high enough to give it a world-wide market range, and competition with South Africa and Soviet Russia has become increasingly severe. As early as 1919 the writer[7] pointed out the danger to Canadian supremacy in United States markets of increasing imports of African fiber into this country, but it was not until 5 years later that active steps were taken by the industry to meet this competition by consolidating companies and exercising economies in mining, manufacture, and marketing. Such consolidations and cost reductions were forced upon the industry by economic conditions, because with the loss of markets to African competitors the struggle for diminishing trade led to price-cutting that was carried to a point where several companies were reduced to bankruptcy, and the margin of profit obtained by any company was extremely small. Since then the industry has been established on a better competitive basis, but with the rapidly increasing output of Russian mines and the concentration of Rhodesian production in the hands of one powerful company, foreign competition is still a serious problem for producers in Quebec whose mines supply substantial quantities of spinning asbestos. Canada made great progress toward placing her products on a better marketing basis by establishing in 1931 a uniform classification of asbestos.

From 1916 to 1924 some interest was aroused in the development of an asbestos industry in Ontario. Good-quality chrysotile was obtained at two points in Doloro Township south of the gold-producing area of Porcupine. A maximum production of 172 tons valued at $91,900 was recorded in 1924. The plant was later dismantled, and no subsequent activity has been reported except the sale of 2 tons valued at $901 in 1926.

Occurrences of chrysotile asbestos of good quality have been reported near Lytton and Revelstoke, British Columbia, but samples from the former locality proved to be weak, brittle amphibole.

Although most Canadian asbestos is exported the manufacture of asbestos products within the country is assuming increasing importance. Before 1921 only 1 company manufactured asbestos products in the Province of Quebec; by 1923 there were 3 plants in Quebec and 1 in Ontario; and in 1932 there were 5 plants in Quebec, 6 in Ontario, 1 in Nova Scotia, and 1 in British Columbia. Products manufactured in 1932 were valued at $1,067,801 compared to a maximum of $2,301,924 in 1930.

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[7] Bowles, Oliver, Mineral Industry during 1919 (chapter on Asbestos): McGraw-Hill Book Co., New York, 1920, pp. 41-42.

Rhodesia

The growth of the asbestos industry in Rhodesia has been almost phenomenal. From an initial output of only 55 tons in 1908 it reached a maximum of more than 42,000 tons in 1929, when of all the minerals produced in the country the value of the output of asbestos was second only to that of gold. Annual production since the beginning of activity is shown in the following table.

Annual production of asbestos in Rhodesia, 1908-33

Year	Short tons	Value	Year	Short tons	Value
1908	55	£552	1921	19,528	£795,698
1909	272	2,722	1922	14,249	577,699
1910	332	3,320	1923	20,364	626,898
1911	460	6,397	1924	26,141	603,423
1912	---	------	1925	34,349	765,926
1913	290	5,224	1926	33,344	726,835
1914	487	8,612	1927	33,176	794,215
1915	2,010	32,190	1928	39,960	970,327
1916	6,157	99,059	1929	42,634	1,186,627
1917	9,562	189,890	1930	37,765	1,070,847
1918	8,574	158,684	1931	24,042	386,494
1919	9,798	425,240	1932	15,766	197,092
1920	18,823	459,572	1933	30,182	555,993

The fiber is of the chrysotile variety occurring in serpentine. It is similar in character and occurrence to that found in Canada and Soviet Russia. There are three producing districts - the Bulawayo, the Victoria (Mashaba), and the Lomagundi - all in southern Rhodesia. Deposits in other localities are known but have not attained commercial importance.

The Bulawayo district is the most important. Its largest mine, the Shabani, opened in 1916, is a prolific producer, providing in prosperous years as much as 1,200 tons of fiber a month. Other important mines in the area are the Birthday, the Nil Desperandum, and the Pangani. The Croft mine at Filibusi has attained some importance.

The asbestos deposits of the Shabani area occur in the central part of a serpentine mass about 10½ miles long and 1 to 3 miles wide. The zone of fiber-bearing serpentine has a length of 2½ or 3 miles and a maximum width of about 200 yards. The serpentine resulted from alteration of dunite, probably under the influence of a granite intrusion. Ore reserves were estimated at 7,000,000 tons in 1928. The fiber, which occurs in seams as much as 6 inches wide, is rarely more than 3 inches long because one or more longitudinal partings occur in most veins, except those that are quite narrow.

For many years the district was handicapped seriously by difficult transportation; 400 wagons and 7,000 oxen were used for conveying supplies and products many miles over poor roads. In 1928 this hindrance was overcome when a 63-mile railway from Shabani to Somabula was completed.

Rhodesian production began in the Mashaba district 46 miles east of Shabani and 26 miles west of Victoria. The principal mines, the King's and Gaths', have been large producers for many years. The fiber is similar in occurrence to that of the Shabani area. A small production has been recorded from the Ethel mine in the Lomagundi district more than 200 miles north of Victoria. Here flexible and brittle fibers occur closely associated, and their separation requires a complex milling system.

In Rhodesia the percentage of long fiber is relatively high; it is estimated that 25 to 30 percent of the fiber produced may be classed as spinning grade, whereas only about 7.8 percent of the Canadian output is of this grade. The difference, however, is not as great as these figures indicate, because large quantities of shorts marketed in Canada are regarded as waste in Rhodesia.

Highly efficient mills for treating the fiber are operated in conjunction with the larger mines. In 1929 all the important mines were consolidated under a single company. The industry is thus placed in a strong competitive position and before 1930 was highly prosperous. Profits of the largest company were 20 percent from 1925 to 1927, 25 percent in 1928, 30 percent in 1929, 11½ percent in 1930, 5 percent in 1931, 3¾ percent in 1932, and 5 percent in 1933. Most of the fiber is exported to Europe and America, chiefly by way of the port of Beira, Portuguese East Africa. Owing to the remoteness of the region from consuming centers only the spinning- and higher-grade mill fibers are sold. Medium grades classed as shingle stock are sold principally in Europe and Australia for building purposes. Very little Rhodesian asbestos of lower grade than spinning stock reaches the American market.

The advantage of unified control was demonstrated in 1931, when rapidly increasing exports from Russia, combined with decreasing demand throughout the World, threatened the continued prosperity of the Rhodesian industry. Turner & Newall, Ltd., who control virtually the entire output of Rhodesia as well as a large part of that from the Union of South Africa, negotiated an agreement with Soviet Russia whereby a fair proportion of the Continental market was preserved for each.

Union of South Africa

More kinds of asbestos are produced in the Union of South Africa than in any other country in the World. Blue asbestos (crocidolite) is produced in large quantities in the Cape of Good Hope; chrysotile and tremolite are mined in small quantities in Natal; while three varieties - chrysotile, crocidolite, and amosite - are mined in the Transvaal. As the last two varieties mentioned are produced commercially nowhere else in the World, it is interesting to review the quantities sold in South Africa during recent years. The following table shows production by kinds.

Production of asbestos in the Union of South Africa,
by kinds, 1926-33, in short tons

Kind	1926	1927	1928	1929	1930	1931	1932	1933
Amosite.....	2,940	5,093	6,748	9,260	3,281	2,087	1,391	3,090
Blue asbes-tos........	4,024	4,873	5,144	6,030	5,431	3,651	2,964	3,225
Chrysotile..	7,133	12,174	12,162	17,747	10,519	9,938	7,715	9,572
Total	14,097	22,140	24,054	33,037	19,231	15,676	12,070	15,887

The output of amosite recorded in the foregoing table is exclusively from the Transvaal; the blue variety comes principally from Cape Province with minor quantities from the Transvaal; while the chrysotile originates almost exclusively in the Barberton district of the Transvaal.

The following table shows annual production by provinces from 1910 to 1933.

Production of asbestos in the Union of South Africa, by provinces, 1910-33, in short tons[1]

Year	Cape of Good Hope	Transvaal	Natal	Total	Value
1910[2]...	680	10	3	693	£ 10,801
1911.....	1,254	--	13	1,267	20,893
1912.....	1,217	--	3	1,220	18,882
1913.....	938	--	24	962	16,028
1914.....	1,160	30	--	1,190	20,087
1915.....	2,083	56	--	2,139	35,899
1916.....	4,228	407	21	4,656	83,070
1917.....	2,999	3,193	28	6,220	87,364
1918.....	-----	-----	--	3,674	54,037
1919.....	3,204	631	98	3,933	66,426
1920.....	3,526	3,541	45	7,112	114,195
1921.....	3,467	1,593	62	5,122	103,067
1922.....	2,991	1,392	6	4,389	81,230
1923.....	4,317	4,076	--	8,393	121,453
1924.....	3,001	4,240	--	7,241	110,075
1925.....	2,540	7,628	--	10,168	152,115
1926.....	3,993	10,104	--	14,097	216,466
1927.....	4,827	17,313	--	22,140	343,301
1928.....	5,078	18,976	--	24,054	399,550
1929.....	6,030	26,984	23	33,037	497,393
1930.....	5,481	13,800	--	19,281	340,795
1931.....	3,651	12,025	--	15,676	246,583
1932.....	2,964	9,106	--	12,070	116,401
1933.....	3,225	12,662	--	15,887	197,120

[1] Figures for 1910-17 from Asbestos in the Union of South Africa: Union of So. Africa Geol. Survey Mem. 12, 1918, p. 134; figures for 1918-32 from statistics of U. S. Bureau of Mines.

[2] Last 7 months.

Cape of Good Hope

The fiber resources of Cape Province consist of crocidolite (blue asbestos), the exploitation of which began about 1893. Asbestos occurs in northern Cape of Good Hope in an extensive belt of banded ironstones of sedimentary origin stretching from a point 20 miles south of Prieska northward beyond Kuruman for a total distance of about 240 miles. The maximum width is about 30 miles. The lavender-blue crocidolite occurs in interbedded cross-fiber veins which are widely distributed throughout the entire length of the belt. Many workings have been opened near Prieska and in the Hay and Kuruman districts. Asbestos is obtained from numerous small pits and from several large underground mines. The fiber ranges from less than 1/2 inch to 1 or 2 inches long, rarely attaining a length of 4 inches. The proportion of spinning fiber is relatively high. Hall[8], who has written a detailed report on the subject, states that 64 percent of the fiber produced by the leading company in 1917 was spinning grade. A highly silicified, pale-brown, semiprecious variety known as "tigereye" or "cat's eye" occurs in small quantities in the Hay district.

The area is so large and fiber veins are distributed so generally throughout it that reserves are doubtless very great. Transportation is difficult, as the nearest railway line is 100 to 130 miles from the workings. Much study and experimentation have been devoted to fiberization and preparation of blue asbestos, with the result that it is used extensively in Europe, but generally it has not been regarded with favor in America. It is applied to both spinning and nonspinning uses.

Transvaal

Chrysotile

Carolina district.-Asbestos was first produced in the Transvaal about 1905 from a deposit of chrysotile east of Carolina. In origin and occurrence it is similar to that found in Arizona. Cross-fiber veins occupy a 5-foot zone of altered dolomite overlying a diabase sill. The veins are parallel with the bedding, which dips 8 to 15° northwest. From 40 to 60 percent of the fiber marketed is over 1 inch long; that less than 1/2 inch long is rejected. Mines have been operated at various times, but production has never been large.

Barberton district.-In 1918 Hall[9] directed attention to a chrysotile deposit near Barberton in eastern Transvaal, but serious development did not take place until after 1921. The deposit occurs in a belt of serpentine bounded by quartzites lying about 3 miles from Kaapsche Hoop and 18 miles by road from Godwin River station. The asbestos-bearing portion of the serpentine has been traced for a length of 3 and a width of 2 miles. Further exploration may extend its boundaries considerably. The most productive fiber belt is 5 to 7 feet thick and dips 10 to 20°. The upper 2 feet, termed "ribbon rock", contains numerous parallel seams of short fiber. The lower 3 to 5 feet contain fewer and thicker seams, which furnish fiber up to 6 inches long. Fiber-bearing rock is not confined entirely to this belt but extends above and below it. Underground mines have been developed extensively near both the eastern and western ends of the 2-mile zone. The fiber is of high quality and easily separated from the massive serpentine.

The asbestos content is unusually high, the fiber in certain sections of the face attaining 33 percent of the total rock mass. In 1926 it was reported that the fiber yield was 22 percent of the rock mined. Furthermore, much of it is long enough for spinning. A close estimate of the output from one of the mines during 1 month in 1923 indicated that 28 percent of the fiber produced was over one half inch long.

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[8] Hall, A. L., Asbestos in the Union of South Africa; Union of So. Africa Geol. Survey Mem. 12, 1918, p. 59.

[9] Hall, A. L., Work cited.

For some years the products of the mines were hauled in ox-and-mule wagons 18 miles to Godwin River station. The completion in 1929 of a 5.9-mile aerial tramway over a 2,000-foot escarpment to Elandshoek made possible a reduction in haulage cost to about one eighth of the amount formerly paid. From this point the asbestos is carried by a short rail haul to Lourenco Marques, Portuguese East Africa, the port of shipment.

The extent of the area, the high percentage of fiber of superior quality in the rock, and the easy access to a seaport make the Barberton district one of the most important asbestos centers in the world. The development of mines in this region is reflected in the rapid increase in production of the Transvaal beginning in 1923, as shown in the table of production in the Union of South Africa by provinces.

Amosite

This unique variety of asbestos occurs most prominently near Penge about 30 miles north of Lydenburg in northeastern Transvaal. The belt extends from the Steelpoort River northwestward along the basin of the Olifants River, thence westward to Chuniespoort. The asbestos occurs in cross-fiber veins interbedded with siliceous ferruginous slates associated with intrusive diabase sills. The principal mines, the Egnep and Amosa, about 1½ miles apart, are situated near Penge. Fiber is obtained from surface workings and from several levels underground. A number of smaller mines and open-pit workings have been operated in the western part of the belt near the Malips River. The fiber veins show remarkable continuity over long distances, and reserves are extensive.

The most notable feature of the asbestos is its length, which attains a maximum of approximately 11 inches and averages about 6 inches for the commercial product. When the material was first marketed difficulties were encountered, because standard equipment for manufacturing asbestos products was not well-adapted for fiber of such great length. With subsequent adjustments the material was prepared extensively for spinning, magnesia pipe covering, and manufacture of other asbestos products.

The future of amosite is uncertain. The claim is made that the relatively large production recorded for 1928 and 1929 was stimulated chiefly by a shortage of chrysotile. As a similar shortage is unlikely to occur again for many years, future activity in the amosite fields will depend primarily on the serviceability of this type of fiber.

Crocidolite

Crocidolite occurs in the western part of the amosite belt - a region designated as the Pietersburg district. It is associated closely with amosite, both varieties being obtained from some of the workings. The blue asbestos is obtained chiefly from open pits near and east of the Malips River. The maximum length of fiber is about 3 inches. Production never has been large. In 1928, the last year for which it was recorded, the output was 66 tons.

Natal

The most important asbestos deposit in Natal is in the Tugela River Valley east of Krantzkop, Zululand. Chrysotile asbestos occurs here in vertical cross-fiber veins near contacts of aplite dikes with green serpentine. Most of the fiber is short and inferior. Production since 1910 has ranged from 2 to 62 tons a year.

A deposit of brittle tremolite asbestos has been worked near the Klip River 45 miles from Dundee - a region where transportation is very difficult. The small amount of material obtained was used for the manufacture of asbestos brick and for insulation.

Soviet Russia

Before the World War Russia ranked next to Canada as an asbestos-producing country. During the revolutionary period the industry was almost at a standstill, but since then it has been revived on an extensive scale.

The asbestos region providing the major part of Russian production comprises what is known as the Bajenova district in the Urals. Principal production is at Asbest, about 90 kilometers northeast of Sverdlovsk (Ekaterinburg). Minor production in this district is obtained from the Alapaevsk area in the north and from the Neviansk area in the northwest. The largest mine in the latter is the Kramouralsk. Outside the Bajenova district the only notable production is from Minusinsk on the Yenisei River in eastern Siberia near the Mongolian border. Here the deposits, said to be of the same general character as those of Arizona, have been worked in a small way, a production of 1,490 tons being reported in 1905. Asbestos also occurs in serpentine in various parts of the Altai Mountains southwest of Minusinsk. A small output was reported from the Katun River district from 1907 to 1909. Deposits occur in other parts of Russia but have not yet attained commercial importance.

At Asbest in the Bajenova district, where the asbestos industry is now centered, 20 or more open pits are worked. They have been under control of the State since 1918 and have been operated by the Uralasbest Trust since 1921. Asbestos was first discovered here about 1710, and systematic development under direction of Baron Girard began in 1885. The asbestos-bearing serpentinized intrusion is about 21 kilometers long and 200 to 1,200 meters wide. It consists of peridotites, which are bounded by schist or slate on the west and by granite on the east. The asbestos is confined to ellipsoidal masses of serpentine, some of which attain a length of 3,500 feet and a width of 1,000 feet. The highest percentage of asbestos is found in the central parts of these masses. The cross-fiber veins generally run north and south with a vertical dip. Slip fiber appears in places. Russian asbestos usually is regarded as being higher in iron that the Canadian fiber, but Ru Keyser 10/ has pointed out that Canadian asbestos is high in ferric

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10/ Ru Keyser, W. A., Chrysotile Asbestos in the Bajenova District, U.S.S.R.: Eng. and Min. Jour., August 1933; p. 338.

iron, whereas in the Russian fiber ferrous iron predominates. This probably accounts for the greater discoloration of the Ural asbestos upon weathering. Russian asbestos deposits have a comparatively shallow overburden and are therefore weathered quite extensively, which may account for the somewhat harsher and less silky condition of the fiber compared with the Canadian. Asbestos occurring below the 50-foot level more nearly resembles that obtained in Quebec. While the percentage of spinning fiber in the Russian deposits is a little higher than that in the Canadian, the percentage of total commercial fiber is about the same.

Extensive and systematic core-drilling indicates a reserve for the entire Bajenova district of more than 3,000,000 metric tons of fiber within 50 feet of the surface. This estimate is based on only a 2-percent recovery; with a probable 4½-percent recovery this quantity would be more than doubled. As the deposits extend far below the 50-foot level it is apparent that the reserves are very great.

Before the revolution crude methods of mining and fiber recovery were practiced, and only the longest grades of fiber - crudes, spinning, and shingle stock - were recovered. The overburden is thin and was removed by hand methods until recent years when power shovels were introduced. Much of the upper rock is soft enough to be mined with picks and shovels. Before 1929 mechanical methods were confined to drilling, but since then cableway hoists and power shovels have been used. Before the advent of mechanical mining much of the concentration also was accomplished by hand methods. As the flow of water is heavy below the 50-foot level the workings consist principally of broad shallow open pits, although some underground development has taken place. A narrow-gage railway was built from Asbest to Bajenova (34 km) in 1927, making possible more intensive development.

There are three major groups of mines in this district. The most northerly, known as the "Proletariat", produces shorts almost exclusively. The two major producing groups are the October (central) and the Ilyinski (southern). Several mills with very crude equipment have been operated for many years. Since 1931 newer and more efficient mills have been built, and new equipment has been installed in some of the old ones. A large asbestos-products industry has been established in Russia, and crudes and spinning fibers, which in former years constituted a large part of the output, have been supplemented by mill products similar to those produced in Canada. Milling methods have been described in detail by Ru Keyser.[11]

Russian production of asbestos has increased from 8,744 tons in 1924 to about 26,500 tons in 1928 and to more than 64,000 tons in 1931. This great increase does not affect world markets as much as might be expected, because increasingly large quantities are used for home consumption. According to recent figures[12] the percentage of Russian asbestos exported dropped from 51.1 in 1922-23 to only 20.5 in 1931. This condition reflects the rapidly expanding manufacture of asbestos products in Soviet Russia. However, these figures tell only part of the story, for they do not indicate the percentage of spinning and higher-grade mill fibers exported. The 50 to 80 percent of the production remaining in the country may consist largely of the shorter fibers which are of minor importance in world trade.

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[11] Ru Keyser, W. A., Asbestos Milling in the Urals: Eng. and Min. Jour., October 1933, pp. 415-19.

[12] Economic Review of the Soviet Union, Oct. 15, 1932, p. 365.

Italy

Italy is called "the cradle of the asbestos industry" because the mining of asbestos and the manufacture of its products began on an industrial scale in that country. Italy also is unique in that much of the fiber produced in early years consisted of tremolite, a variety of amphibole asbestos little used elsewhere. Before discovery of the Canadian deposits Italy was the chief source of supply of asbestos for both Europe and America. After the Quebec deposits were developed the Italian industry experienced little growth. Production from 1898 to 1931 is shown in the following table.

Annual production of asbestos in Italy, 1898-1931, in metric tons

Year	Tons	Year	Tons	Year	Tons
1898	131	1910	175	1922	540
1899	81	1911	170	1923	1,538
1900	126	1912	169	1924	2,160
1901	243	1913	175	1925	2,105
1902	243	1914	171	1926	2,900
1903	202	1915	163	1927	3,840
1904	182	1916	82	1928	4,950
1905	220	1917	85	1929	2,847
1906	209	1918	60	1930	851
1907	359	1919	98	1931	632
1908	359	1920	165	1932	1,284
1909	190	1921	420		

One important deposit is in the Susa Valley region of western Torino near the French border. Here tremolite asbestos, which is particularly well-adapted to the manufacture of acid filters, is mined in the mountains 8,000 to 9,000 feet above sea level. A second deposit is along the Aosta Valley near Ivrea in northeastern Torino, about 46 miles from Turin. Tremolite asbestos has been mined in the mountains in this locality since 1865, but there has been little activity since 1905. The fibers are long and highly resistant to acids and heat, but owing to the difficulty of separating them they are not well adapted to weaving. A third source of supply of tremolite asbestos is near Sondrio in northern Lombardy. This asbestos also is a long-fibered variety similar to that of the Torino deposits.

The Balangero mine situated in Torino about 20 kilometers north of Turin has been the chief producer during recent years. The asbestos of this district is chrysotile, the output of which was about 2,000 tons in 1925 and nearly 5,000 tons in 1928, the year of greatest production. In 1928 modern mechanical mining equipment was introduced. The fiber is said to be inferior to Canadian chrysotile for spinning purposes. It commands prices ranging from $75 to $150 a ton and is used chiefly for the manufacture of artificial stone.

Asbestos was produced in Sardinia in 1926, and deposits are reported in Corsica.

Italy is both an importer and an exporter of asbestos. Practically all the fiber required for textile use and considerable quantities of the shorter grades are imported, while small quantities of filter asbestos and other nonspinning grades are exported.

MINOR FOREIGN DEPOSITS

Asbestos deposits of minor importance are covered in following pages by countries arranged in alphabetical order.

Argentina

Deposits of asbestos are reported at Alta Gracia, Cordoba; Sierra de la Cortadera, Mendoza; Fiambala, Catamarca; and in the Provinces of San Luis and San Juan. The fiber is said to be too short for spinning or weaving, and production has been very small. The only available figures show an output of about 42 short tons in 1926 and of less than a ton in 1927.

Australia

Western Australia.-Chrysotile asbestos of good quality occurs in several places in Western Australia. The more important developments are at Lionel in the Nullagine district, Soanesville and Cooglegong in the Marble Bar area, and Roeburne in the West Pilbarra district. A small production, ranging from 10 to 230 tons, has been recorded each year since 1920. Spinning fiber is available, and the deposits probably are extensive. The material appears to be of exceptionally high quality, as that shipped to London in 1929 commanded £120 to £150 a ton. A small shipment made in 1933 was valued at £80 a ton.

South Australia.-A promising deposit of crocidolite occurs 10 miles north of Hawker, about 248 miles north of Adelaide. Apparently it is derived from magnesian limestone. The maximum length of the fiber is about 2 inches, but most of the asbestos is short and matted. Two shafts 40 feet apart have been sunk to a depth of 26 feet and connected with a drift. Unfortunately, the ore body is faulted at the 26-foot level, and nothing is known of its continuation. Bluish gray crocidolite occurs as bunches and veins in dolomitic limestone at Robertstown, 83 miles from Adelaide. It is said to have excellent heat-insulating qualities. Other occurrences have been noted at Kapunda, Truro, Mt. Baker, Gumeracha, and Williamstown.

Chrysotile of good quality occurs at Mimbric near Cowell. Veins attaining a maximum width of 2 inches appear in serpentine traversing marble. According to report, the asbestos-bearing rock would yield 0.5 percent crude and 15 to 20 percent mill fiber. Annual production ranging from 5 to 21 tons has been noted in South Australia for various years.

Queensland.-Asbestos occurs in many parts of the Rockhampton district, but the deposits have not been fully explored. Chrysotile fiber up to 1½ inches long of good spinning quality has been reported from a deposit near Marlborough. A small quantity has been sold at £25 a ton.

New South Wales.-A chrysotile asbestos deposit was worked in a small way near Barraba for several years following 1918. Short-fiber chrysotile occurs in a belt of serpentine about one half mile wide. The area is greatly faulted, which makes mining difficult. A small mill similar to those in Quebec was operated for a time, and fiber recovery is said to have been 5.75 percent of the rock treated. Crocidolite occurs near Gundagai and Broken Hill, but the percentage of recoverable fiber is said to be low.

Tasmania.-An occurrence of asbestos at Beaconsfield was discovered more that 30 years ago, a production of 200 tons being recorded in 1899. It is of the chrysotile variety, occurring in irregular and noncontinuous veins in a serpentine belt 2 miles long and 1½ miles wide. The fiber rarely reaches an inch in length; commonly it is one eighth inch long. The asbestos-bearing area is not very large, and the veins so far uncovered are too scattered and irregular to encourage deep working. A limited production of asbestos of fair quality is possible. The fiber has a higher iron content than Canadian asbestos. A mill for ore treatment was erected in 1917, but very little fiber has been produced.

A promising deposit of asbestos in serpentine is reported on the western shore of Macquarie Harbor 16 miles south of Strahan. It is undeveloped.

Austria

Short-fibered amphibole, known as "microasbestos", is mined in Austria near the Hungarian frontier. It is mixed with both asphalt and concrete used for road surfaces.

Brazil

An undeveloped asbestos deposit of uncertain type is reported near Rio Branco, Pernambuco.

Bulgaria

Amphibole asbestos of the anthophyllite type occurs over a large area in the eastern Rhodope Mountains of southern Bulgaria. A production of several hundred tons was reported unofficially in 1933.

China

Asbestos, said to be of the chrysotile variety, occurs in a number of provinces in China, including Chihli, Jehol, Chahar, Suiyuan, Shensi, Szechuan, Hupeh, and Kwangtung. The Laiyuan mines in Chihli probably are the most important. The deposits cover a considerable area and were worked by four companies in 1927. Most of the product, part of which evidently is spinning grade, is shipped to manufacturing plants in Tientsin. Annual production does not exceed a few hundred tons. Asbestos mines about 5 miles from Chinchu, Manchuria, have been worked in a small way for more than 20 years. The output has been shipped to Japan.

Cyprus

The chief asbestos deposits of Cyprus occur at Amiandos on Mt. Troodos in the west-central area. A peridotite plug consisting largely of olivine is altered to serpentine on the periphery. Short-fiber chrysotile asbestos occurs in the serpentine in irregular veins which have a maximum thickness of about one half inch. Faulting and shearing evidently have exerted a definite influence on development of the fibrous structure. The asbestos content of the rock runs only 1 to 2 percent. The deposit is evidently extensive, but no information on reserves is available.

Although the fiber is of the chrysotile variety it is too short for spinning. Milled fiber is graded into three classes - standard, shorts, and fines. The standard grade, designated "shingle stock", is said to comprise about 90 percent of production.

About 1925 an aerial ropeway 18 miles long was constructed for conveying the asbestos from Amiandos to the seaport at Limassol. The construction cost was about £2,320 a mile. The cost of transporting asbestos by means of the ropeway, including interest on investment and complete amortization of the equipment in 10 years, was given as 6s. 9d. a ton, whereas motor-wagon or animal-transport formerly employed on the 37-mile winding road cost 20 to 25s. a ton.

The industry attained considerable importance from 1926 to 1929, but thereafter the demand fell off greatly. It is reported that operations were conducted at a substantial loss in 1932. As there are no local asbestos-products plants the entire output is exported, principally to European countries. Exports began in 1906. Figures for tonnage and value of exports over a period of years are shown in the following table.

Asbestos exported from Cyprus, 1922-33

Year	Long tons	Value	Year	Long tons	Value
1922	2,285	£ 22,899	1928	11,579	£ 231,692
1923	2,115	57,115	1929	13,796	292,971
1924	4,372	80,070	1930	5,400	116,092
1925	3,290	54,639	1931	3,571	66,381
1926	6,331	121,857	1932	1,600	27,214
1927	10,904	207,562	1933	1,158 1/	------

1/ First 6 months of 1933, as reported in Bull. Imp. Inst., London, vol. 31, no. 3, 1933, p. 423.

Finland

Asbestos production is confined to a locality in Tuusniemi Parish, east-central Finland, where 1,000 to 1,500 tons of amphibole fiber are mined annually. The material is used in a factory at Helsingfors for the manufacture of building materials and other asbestos products. A small quantity of actinolite has been mined in northern Finland.

India

It is claimed that India has considerable undeveloped asbestos resources. The most important deposits are in Saraikela and the next largest in Mysore. No data are available as to type or quality.

Ireland

An asbestos deposit at Avoca, County Wicklow, was reported in 1931. No data are available on variety, quality, or extent.

Mexico

An unusually good sample of mountain cork - a variety of spongy, matted, amphibole asbestos - was obtained by the Bureau of Mines in 1931 from an undeveloped deposit near San Luis Potosi. According to report, surface exposures indicate that it is extensive.

Newfoundland

A deposit of chrysotile asbestos discovered near Port au Port is thought to represent a continuation of the Quebec belt. No data are available as to its quality or extent.

New Zealand

Chrysotile asbestos in veins as much as 3 inches wide occurs in a serpentine area at least 3 miles long near Mt. Arthur in the upper Takaka district. Both cross fiber and slip fiber are available. The cross-fiber veins occur principally in shells 6 to 30 inches thick surrounding cores of massive serpentine with few or no veins. The fiber yield of the shells is estimated at 10 to 25 percent. The deposit evidently is extensive and is undeveloped.

Philippine Islands

A deposit of amphibole asbestos occurs in Ilocos Norte Province on Luzon Island. A considerable quantity was mined about 1920 for pipe covering and similar uses.

Portugal

Asbestos of uncertain quality, probably in deposits of limited extent, is reported in two places in the Beja district, Province of Alemtejo, southern Portugal. No production is recorded.

Spain

Two occurrences of chrysotile asbestos were reported in 1920, one in the Pyrenees and the other in the Cantabrian Mountains. A production of 165 metric tons was recorded for that year, but no subsequent activity has been noted.

Switzerland

Asbestos occurs in the Cantons of Grisons, Tessin, and Valais. Production is small; a maximum of about 400 tons was obtained under the war stimulus of 1918 and 1919. The most important deposits are at Poschiavo in the Canton of Grisons, where a small amount of chrysotile of spinning quality is available.

Turkey

A small output of asbestos has been reported near Kutaia, western Turkey. In 1932 an output of 58 tons was recorded with a value of about $24 a ton. Very promising samples of cross-fiber chrysotile were obtained by the Bureau of Mines in 1934 from a deposit said to occur near Sarikamis, Province of Kars, Turkish Armenia. The percentage of fiber to rock runs very high, and a fair proportion of crude asbestos evidently is obtainable. No details as to the extent of the deposit or its availability have been obtained.